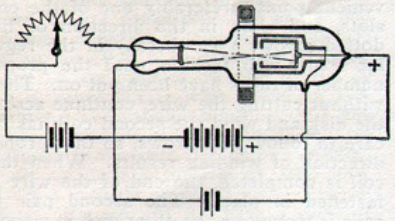
A Triode Antedating De Forest's Tube?

By D. C. WILKERSON

A bit of interesting history on the evolution of cathode ray tubes from the early Crookes tube to the Von Lieben triode. The latter, partly in principle and partly in design, parallels the present day three element tube.

THE information given in this article will come as a shock to many well informed radio fans, amateurs of long standing, manufacturers and engineers in the electrical business. We have been led to believe that the origin of the three electrode idea lay with our own Doctor Lee DeForest.

All this is more or less ancient history



Von Lieben Tube

The Von Lieben Cathode Ray Relay, and the circuit, patented on March 4, 1906, three months and twenty-two days before DeForest's three electrode tube patent.

for the average radio fan who keeps abreast of the times and reads the usual amount of radio literature. The date of Dr. DeForest's first radio tube patent is given as June 26, 1906, the patent being numbered by the Patent Office as 824,637; the next was 836,070, November 13, 1906.

Simultaneous with the work of Dr. DeForest, a group of foreign scientists were digging at the problem of the electronic relay. Wehnelt developed a series of metallic oxides which showed extreme sensitivity to heat and high cathode emission in a vacuum. Robert von Lieben, of Vienna, has been mentioned in many scientific works as an originator of novel ideas in cathode and other types of ray emitting tubes.

THE X-RAY TUBE

Let us hark back to the discoveries of Röntgen. In the early '90's, the world of science was just beginning to make headway with the so-called cathode tube, produced and modified by Crookes, J. J. Thomson and others. Dr. Röntgen, in testing the strength of the field of cathode ray influence in 1895, found that the rays produced by an ordinary cathode tube caused phosphorescence in bodies outside the tube, and that a photographic plate was affected by the rays. He succeeded in photographing a door key through a leather pocketbook by means of this ray emission, which he named X-ray.

The ordinary X-rays as they were originally produced were developed by means of an evacuated tube containing two electrodes, a cathode having a semi-spherical surface and the anode being a flat plate, the center of which was also the center of curvature of the cathode. The terminals of a high frequency source, spark coil or electrostatic machine were connected to the two terminals of the tube, the negative lead being connected to the curved surface cathode.

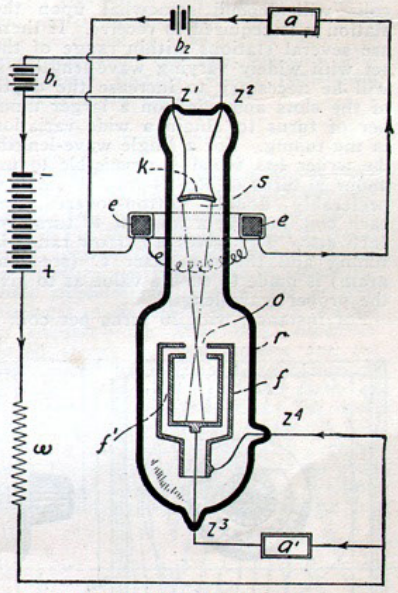
The high degree of exhaustion within the tube caused a much greater difference of interior electrode potential, and this was found to accelerate the speed of emission of the rays. In the simple cathode tube, having a comparatively gaseous content, or a vacuum of relatively low exhaustion, the speed of emission was slow, and the cathode particles being small, negative electrons moving slowly were easily deflected by magnetic or other means applied at right angles to the direction of flow.

Dr. Röntgen evacuated his tube to a high degree and the corresponding increased difference of interior electrode potential imparted a higher velocity to the cathode stream. In other words, the ordinary cathode stream gives off soft rays and the X-rays are hard. The harder these rays, the higher the degree of penetration beyond the tube. Determined by Dr. Marx as having the speed of light, they were not deflected by the application of a magnetic or electrostatic field.

THE COOLIDGE X-RAY TUBE

Our own Dr. Coolidge found that he could heat the cathode by means of a separate external circuit and that the resulting stream of negative electrons emitted could be bombarded against the anode with a sufficiently high velocity to develop X-rays. His tube, being a great improvement upon other types, because of the economy of current, universality of use, and more sure control of the various functions of the tube, has found a ready use universally since its disclosure.

He showed conclusively that the penetrating power of the rays depended on the voltage of the secondary, and that the breadth or density of the emission stream was parallel to the degree of heat emission at the cathode.

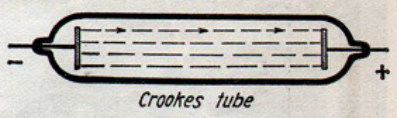


"A," "B" and "C" batteries are provided in the circuit of the Von Lieben tube, with the plus "B" connecting to the anode (plate) of the tube.

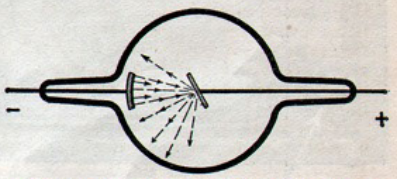
In the three electrode relay tube devised by Von Lieben, the influence of the Röntgen ideas are seen. Von Lieben, in working out a practical method to control emission, borrowed from Wehnelt the metallic oxide surface as a source of electron emission, took the curved surface of Röntgen as the proper shape for his emitter electrode, and projected the resulting electron beam through a tubular shaped grid member, the aperture of which was charged and discharged from an external circuit source electromagnetically or electrostatically.

In the original DeForest patent, both magnetic and electrostatic means for applying a third electrode current were included and in some of the DeForest cases a horseshoe-shaped magnet was wire wound and placed in such a position that its field would influence the electron flow or cathode stream in the tube.

It must be remembered that the "cathode ray" of 20 years ago, having a relatively slow electron flow, has become known as an electron stream today, and we have learned that this flow is composed of tiny electrons traveling from the heated filament to the positively charged plate, which because of the law of opposites exerts an attracting influence on the negative electrons.



Crookes tube



The original Crookes tube produced a soft ray; this produced by the cathode stream. The Roentgen tube shown below, because of its high evacuation, gave off hard rays, known today as x-rays.

At the time of the filing of the DeForest claims, and before, this truth about the character of flow was not known, and Dr. DeForest himself admitted that he could not explain the actual character of the phenomenon he had discovered and filed patent applications on.

His collector electrode was a tube.

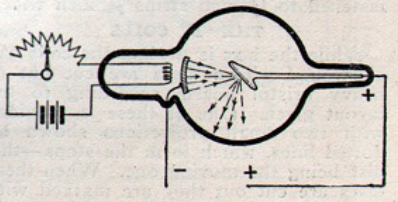
The variations from the changing charges upon the surfaces of the control electrode produced corresponding changes in the external circuit of the collector electrode just as we know of it in modern radio tubes.

THE VON LIEBEN PATENT

The patent was filed on March 4, 1906, in the German Imperial Patent Office three months, twenty-two days before DeForest's, and issued November 19, the same year, for a Cathode Ray Relay. The patent papers were received and stamped in the United States Patent Library, December 19, 1906, making them a matter of public record in the United States on that day.

The direct translation clearly states that

(*Continued on page* 1754)



Coolidge tube

In the Coolidge tube, the cathode is heated by an external circuit, and the velocity of the negative electrons bombarding the anode so increased as to produce X-rays.

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A crystal of the fixed type is used in this case. It is of the cartridge type and is placed between the two clips mounted at the center top of the panel. This type will be found best for use, since it does away with the annoyance of constant adjustment necessary in the ordinary type. Just a hint here may save the builder a deal of exasperation. No matter how fixed a crystal detector may be, dropping it on the floor or throwing it at the cat may make it lose its sensitivity. Too, an extra strong signal will cause the point to burn out. Therefore, it may be advisable to have an extra refill for it at hand. The ordinary type may be used, but the fixed one seems to be the lesser of two evils.

An aperiodic primary is used on the tuner, reducing the controls. It consists of six turns placed directly on the bakelite strips which support the secondary. It should be of large wire, No. 14 serving admirably.

The location of the instruments on the baseboard is clearly indicated in the illustration.

Ninety volts of "B" battery were used on the plates of the tubes which were 201A's and very good volume was obtained. Local five kilowatt stations have a habit of causing distortion in the set with this high voltage, however, so be careful when tuning in such transmitters.

All in all, this is a reflex idea worth while. It has stability and a reasonable amount of added signal strength at the loud speaker. It also has—and this point is becoming more and more important—perfect clarity of reproduction on account of the use of a crystal as the rectifier.

A Triode Antedating DeForest's Tube?

(*Continued from page 1671*)

the invention relates to a device for releasing energy in a relay manner, and it definitely mentions *telephone* and *telegraph relay* purposes as its object, as well as the carrying of *wireless telephone* messages, the amplifying and building up of *speech* and *music* transmission, and *telephotography*.

Von Lieben also clearly states that he desires to utilize a vacuum in which an electronic stream will be emitted in a circuit with a potential of 200 volts. This clearly outlines the degree of vacuum in use today in the modern radio receiving tube concerning which a controversy between Arnold and Langmuir is now raging, there being two conflicting patent claims before our Patent Office Board of Examiners, in which the use of a "hard" vacuum is claimed. These patents on the vacuum question have not been issued.

It will be noted in the circuit shown by Von Lieben that he provides for a "B" battery, and for a "C" battery in the external circuits connected to the tube electrodes. He also takes up the proposition of transmission and mentions the use of a microphone in the grid circuit, even showing its position.

Another point is that the external circuit of the collector electrode shows the positive terminal of the "B" battery connected to the plate, and that *a means of feed-back* is shown in "apparatus A," though not claimed in the patent specifications.

THE WEHNELT OXIDE COATING

Altogether, this Von Lieben patent has a very strong bearing on the development of the vacuum tube today, for it shows a structure which will be very important in the coming 110-volt receiving tubes which are due to be placed upon the market within a short time. The Wehnelt oxide coating as a source of electron emission has withstood the test of science for more than 20 years. The

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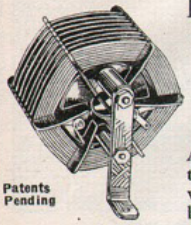

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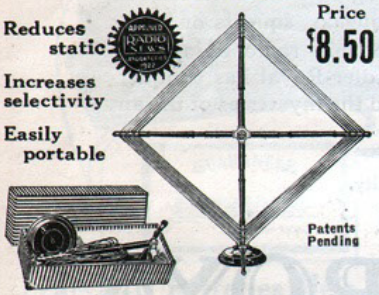

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In manufacturing tubes which utilize Wehnelt-coated sources of emission, the craftsman makes a compound of strontium and barium oxides with resin, wax or paraffin, in a sort of soft, doughy solution. This compound is painted on strips of platinum-iridium alloy. As each painted coat dries, it is burned off, and successive coats applied and burned off until as many as 12 to 15 layers of oxide are applied, the final piece being used as a vacuum tube filament.

This class of Wehnelt filament is known as the "dull emitter" type, since a very small amount of electrode heat is required to generate a heavy stream of electrons. In the recent attempts by manufacturers to create a design of 110-volt tube, the Wehnelt coat, heated from an electrically disconnected source, has been tried with fairly good results. In this type, glass tubes electrolytically coated with silver upon which the oxides are deposited are used as sources of emission. The heating element in such tubes is located adjacent to the emitter and operated from a 110-volt current supply.

Radio Anticipations for 1925

(*Continued from page* 1673)

was first in the field in the radio game and that we have a tremendous vested interest which ought to be considered. The use of radio is of military necessity and for the sake of the safety of our own ships, as well as merchant vessels, there is also a necessity in peace time for radio. Therefore, it is neither reasonable nor possible to shut down a Government or commercial station offhand, simply because the broadcast listeners complain of it.

"Nevertheless, as far as the navy is concerned, I can assure you that we are making every effort to reduce the interference caused by our stations. If the work seems to progress slowly, it is because the ordinary broadcast listener does not appreciate the tremendous technical difficulties involved and the very great cost of the conversion of such a large number of stations afloat and ashore to stations of the non-interfering type. Our efforts are, moreover, hampered by the unwillingness of broadcast listeners themselves to use suitable receivers.

"However, our work is progressing systematically and regularly and we have made many concessions and spent many hundreds of thousands of dollars in improving conditions both afloat and ashore, and as rapidly as possible and as fast as the money is available, are scrapping old equipment even though much of it is still capable of excellent service from a naval point of view.

"Incidentally, a large amount of interference has been charged to naval stations which investigation has shown not to have originated with them. This is the result of broadcast listeners failing to learn a few letters of the code, thus enabling them to identify a station's call. Broadcasting, however, has done the naval radio interests an immense amount of good. Most of our naval officers, whether they be in communication work or not, from their experience with broadcast receivers, know something of the radio game and talk its language. I think broadcasting is largely responsible for a better appreciation of the possibilities as well as the difficulties of radio communication in the naval service.

THE SELECTIVE RECEIVERS

"The man on a rural telephone line, where a number of parties are on the same line, with more or less inadequate operators, can not expect the same service as the man who

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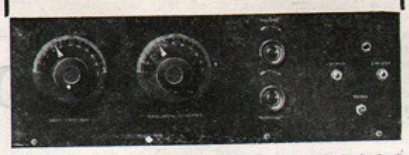

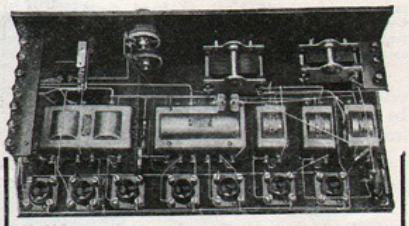

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